



February 18, 2014

FOUNDATION INVESTIGATION REPORT

High Mast Light Poles Highway 401/Holt Road Interchange Reconfiguration Clarington, Ontario G.W.P. 2101-08-00

Submitted to:
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GEOCRES No. 30M15-165

Report Number: 09-1111-0019

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REPORT





Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	1
3.0 INVESTIGATION PROCEDURES	1
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS	3
4.1 Regional Geology	3
4.2 Subsurface Conditions.....	3
4.2.1 Topsoil	4
4.2.2 Asphalt	4
4.2.3 Sand Fill	4
4.2.4 Clayey Silt Fill	4
4.2.5 Silty Sand.....	5
4.2.6 Clayey Silt (Till)	5
4.2.7 Silt and Sand (Till).....	5
4.3 Groundwater Conditions	6
5.0 CLOSURE.....	6

REFERENCES

DRAWINGS

Drawing 1 Borehole Locations

APPENDIX A Borehole Records

Lists of Abbreviations and Symbols

Record of Boreholes:

13-1, 13-2, 13-3, 13-4, 13-11, 13-15, 13-16, 13-19, 13-20, 13-23, 13-46, 13-50

APPENDIX B Laboratory Test Results

Figure B1 Grain Size Distribution Test Results – Clayey Silt (Fill)

Figure B2 Plasticity Chart – Clayey Silt (Fill)

Figure B3 Grain Size Distribution Test Results – Clayey Silt (Till)

Figure B4 Plasticity Chart – Clayey Silt (Till)

Figure B5 Grain Size Distribution Test Results –Silt and Sand (Till)



**FOUNDATION REPORT - HIGH MAST LIGHT POLES
HIGHWAY 401/HOLT ROAD INTERCHANGE**

PART A

**FOUNDATION INVESTIGATION REPORT
HIGH MAST LIGHT POLES
HIGHWAY 401/HOLT ROAD INTERCHANGE RECONFIGURATION
CLARINGTON, ONTARIO
G.W.P. 2101-08-00**



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the Highway 401/Holt Road Interchange reconfiguration in the Town of Clarington, Regional Municipality of Durham, Ontario.

This report addresses the results of the detail subsurface investigation carried out for the High Mast Light (HML) Pole foundations.

The Terms of Reference for the foundation engineering services are outlined in MTO's Request for Proposal (RFP) for Assignment No. 2008-E-0059 dated March 2009 and associated clarifications, and in Section 6.8 of the URS *Technical Proposal* for this assignment. The Scope of Work for the HML foundation investigation is summarised in Golder's Scope Change Letter dated January 31, 2014.

2.0 SITE DESCRIPTION

The existing Highway 401/Holt Road Interchange is located near the entrance to the Darlington Nuclear Power Plant, approximately 10 km east of Oshawa, Ontario.

Based on the drawings of the proposed new Highway 401/Holt Road Interchange provided by URS (Drawing No. 2013-10-24-Hwy401-HoltRd_profile and 2013-10-24-Hwy401-HoltRd_plan), the existing Holt Road will be realigned and a new bridge structure with associated interchange ramps will be constructed about 30 m to the east of the existing underpass bridge. Further, it is understood that the South Service Road will be realigned to the south as part of the interchange reconfiguration, to accommodate the future Highway 407 East Durham Link that connects to Highway 401 immediately to the west of the site.

In general, the terrain in the area of the proposed new interchange is relatively flat to gently rolling, with the natural ground surface within the limits of the project ranging between about Elevations 111 m and 116 m.

The proposed HML poles are located at the roundabouts immediately north and south of the proposed Holt Road bridge structure, at the intersection of Holt Road and the interchange ramps, as shown on Drawing 1, and summarised below.

- HML 1 – Holt Road roundabout south of Highway 401 at about Station 10+091, and
- HML 2 – Holt Road roundabout north of Highway 401 at about Station 9+795.

3.0 INVESTIGATION PROCEDURES

As part of the foundation investigation for the interchange reconfiguration (Golder 2013 (a) and (b)) fifty one (51) boreholes (Boreholes HR-1, HR-2, 13-1 to 13-21 and 13-23 to 13-50) were advanced on November 22, 2012 and between May 27 and August 22, 2013 to investigate the subsurface conditions at the proposed bridge structure, high fill embankments and deep cut areas. The boreholes from this investigation located in the area of the proposed HML poles have been used in this report, namely Boreholes 13-1 to 13-4, 13-11, 13-15, 13-16, 13-19, 13-20, 13-23, 13-46 and 13-50, and specifically the boreholes which are closest to the proposed HML Poles, Boreholes 13-2, 13-11 and 13-19.



FOUNDATION REPORT - HIGH MAST LIGHT POLES HIGHWAY 401/HOLT ROAD INTERCHANGE

The boreholes were drilled by conventional track and truck mounted drill rigs supplied and operated by KC Drilling Ltd. of Innisfil, Ontario and Strong Soil Search Inc. of Claremont, Ontario. The boreholes were advanced through the overburden using 108 mm, 120 mm and 150 mm solid stem augers. In general, samples of the overburden soils were obtained at intervals of depth ranging from 0.75 m to 1.5 m using a 50 mm outer diameter (O.D.) split-spoon sampler operated by an automatic hammer on the drill rigs, performed in accordance with Standard Penetration Testing (SPT) procedures, as specified in ASTM Method D1586.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations, and monitored in a piezometer installed in one of the boreholes, and are described on the Record of Borehole sheets in Appendix A. It should be noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations in precipitation and on local soil permeability. All boreholes were abandoned by backfilling to the ground surface with bentonite upon completion in accordance with Ontario Regulation 903 (as amended).

The three boreholes specific to the HML Pole locations were advanced to depths between 4.6 m and 7.7 m below existing ground surface, generally penetrating below ground surface to a depth equivalent to the proposed height of the embankment fill and a minimum of 2 m into "refusal" material (SPT N-values > 100 blows per 0.3 m of penetration).

The proposed centreline of each roadway and ramp alignment was staked at 50 m intervals in the field by URS prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates using the base drawing provided by URS in AutoCAD format. Borehole elevations were surveyed by a member of our technical staff in reference to the surveyed ground surface elevations at the centreline median. The locations of the closest borehole(s) to the proposed HML poles shown on Drawing 1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

Summary of Borehole Locations and Elevations

HML Pole Designation	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
HML 1	13-2	4860647.0	367303.2	116.3	7.7
HML 2	13-11	4860938.7	367308.4	109.7	4.7
	13-19	4860918.3	367294.0	110.0	4.6

Prepared by: MWK, Checked by KJB

The field work was observed by members of our engineering and technical staff who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further detailed visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. The results of the laboratory



FOUNDATION REPORT - HIGH MAST LIGHT POLES HIGHWAY 401/HOLT ROAD INTERCHANGE

classification testing are summarized on the Record of Borehole sheets and are included in Appendix B for the three specific boreholes drilled closest to the HML Pole locations.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)¹ and *Urban Geology of Canadian Cities* (Karrow and White, 1998)². The Iroquois Plain extends around the western shores of Lake Ontario. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in this area of the Iroquois Plain are typically comprised of glaciolacustrine clays, silts and sands to gravelly sands, which are underlain by an extensive till deposit that is mapped in this area as the Bowmanville Till. Within the area approximately bounded by Holt Road and Morgan's Road, the surficial glaciolacustrine deposits are absent or of limited thickness and the Bowmanville Till unit is frequently present immediately below the ground surface. Between these limits, an extensive surficial deposit of clayey silt to silty clay is present over the Bowmanville Till (Karrow and White, 1998). More recent alluvial deposits of gravel, sand, silt and/or clay are present in the valleys associated with Bowmanville Creek, Soper Creek, Wilmot Creek and Graham Creek.

The overburden soils are underlain by limestone bedrock of the Lindsay Formation, Simcoe Group (Geological Survey of Canada, 1997).³

4.2 Subsurface Conditions

The borehole locations and ground surface elevations are shown on Drawing 1. The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the borehole records contained in Appendix A. The results of geotechnical laboratory testing on samples from pertinent boreholes are also presented on Figures B1 to B5 contained in Appendix B.

The stratigraphic boundaries shown on the borehole records are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

The description of the subsurface conditions encountered at the site in the following sections is based on the three (3) boreholes advanced as part of the high fill and deep cut investigation that are closest in proximity to the HML Pole locations (Boreholes 13-2, 13-11 and 13-19). The subsurface conditions encountered in these boreholes are generally consistent with the subsurface conditions encountered in the other boreholes advanced in the general vicinity of the HML pole locations as shown on Drawing 1 and presented on the Record of Borehole sheets included in Appendix A.

¹ Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

² Karrow, P. F., and White, O. L., 1998. *Urban Geology of Canadian Cities*. Geological Association of Canada Special Paper No. 42. St. John's, Nfld.

³ Ontario Geological Society, 1991. *Geology of Ontario*. Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.



In summary, the subsurface conditions encountered at the site consist of a surficial layer of asphalt underlain by a fill deposit comprised of sand, some gravel, to clayey silt or a topsoil layer underlain by a silty sand deposit. The silty sand and fill deposits are underlain by a very dense/hard silt and sand to clayey silt till deposit.

A more detailed description of the subsurface conditions encountered in the three boreholes is provided in the following sections. The subsurface conditions for each specific HML pole location can be inferred from the closest borehole.

4.2.1 Topsoil

A 0.3 m and 0.4 m thick deposit of topsoil was encountered immediately below ground surface in Boreholes 13-11 and 13-19.

One Standard Penetration Test (SPT) “N” value measured within the topsoil deposit is 23 blows per 0.3 m of penetration, suggesting a very stiff consistency.

The natural water content measured on one sample of the topsoil is 14 per cent.

4.2.2 Asphalt

An approximately 0.15 m thick layer of asphalt was encountered in Borehole 13-2 at ground surface.

4.2.3 Sand Fill

A fill deposit comprised of sand, some gravel, trace silt was encountered below the asphalt in Boreholes 13-2. The surface of the granular fill deposit was encountered at Elevation 116.1 m and the deposit is 0.6 m thick.

The natural water content measured on one sample of the granular fill is 3 per cent.

4.2.4 Clayey Silt Fill

A deposit of sandy clayey silt to clayey silt fill was encountered below the sand fill in Borehole 13-2. The cohesive fill deposit also contains trace to some gravel, trace organics and rootlets. The surface of the cohesive fill deposit was encountered at Elevation 115.5 m and the deposit is 4.8 m thick.

The measured SPT “N”-values within this deposit range from 23 blows to 106 blows per 0.3 m of penetration, suggesting a very stiff to hard consistency.

The results of grain size distribution tests completed on two selected samples of the clayey silt fill are shown on Figure B1 in Appendix B.

Atterberg limits testing conducted on one selected sample of the clayey silt fill measured a plastic limit of about 13 per cent, a liquid limit of about 20 per cent and a plasticity index of about 7 per cent. This test result, which is plotted on a plasticity chart on Figure B2 in Appendix B, indicates that the fill consists of clayey silt of low plasticity.

The natural water content measured on two selected samples of the clayey silt fill deposit is about 13 per cent and 15 per cent.



4.2.5 Silty Sand

A granular deposit comprised of silty sand, trace gravel, trace clay was encountered underlying the topsoil in Borehole 13-19. The surface of the silty sand deposit was encountered at a depth of 0.3 m below ground surface (Elevation 109.7 m), and the deposit is 1.2 m thick.

The measured SPT “N”-values within this deposit are 16 blows and 73 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The natural water content measured on one selected sample of the silty sand deposit is about 11 per cent.

4.2.6 Clayey Silt (Till)

A deposit of clayey silt till was encountered below the fill in Borehole 13-2, and below the topsoil in Borehole 13-11. The surface of the clayey silt till was encountered at depths of 5.6 m and 0.4 m below ground surface, corresponding to Elevations 110.7 m and 109.3 m in the respective boreholes. The thickness of this till deposit is about 2.1 m and 4.3 m in the respective boreholes and was not fully penetrated.

The measured SPT “N”-values within this deposit range from 50 blows per 0.13 m of penetration to 50 blows per 0.05 m of penetration, suggesting a hard consistency.

The till deposit consists of clayey silt with sand, trace to some gravel. The presence of cobbles and boulders within this deposit was inferred from grinding of the augers as noted on the Record of Borehole sheets. The results of grain size distribution tests completed on three selected samples of the clayey silt till are shown on Figure B3 in Appendix B.

Atterberg limits testing was conducted on two selected samples of the clayey silt till and measured plastic limits of 9 per cent and 10 per cent, liquid limits of about 15 per cent and plasticity indices of about 5 per cent and 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B4 in Appendix B and indicate that the material is a clayey silt of low plasticity.

The natural water content measured on samples of the clayey silt till deposit ranges from about 5 per cent to 9 per cent.

4.2.7 Silt and Sand (Till)

A deposit of silt and sand till was encountered underlying the silty sand deposit in Borehole 13-19. The surface of the silt and sand till deposit was encountered at a depth of 1.5 m below ground surface, at Elevation 108.5 m, and the borehole was terminated within this till deposit at a depth of 4.6 m below ground surface corresponding to Elevation 105.4 m.

The measured SPT “N”-values within this deposit range from 50 blows per 0.1 m of penetration to 50 blows per 0.05 m of penetration, indicating a very dense relative density.

The glacial till deposit consists of silt and sand, some clay, trace to some gravel. The presence of cobbles and boulders within this deposit was inferred from grinding of the augers as noted on the Record of Borehole sheet. The results of grain size distribution tests completed on two selected samples of the silt and sand till are shown on Figure B5 in Appendix B.



FOUNDATION REPORT - HIGH MAST LIGHT POLES HIGHWAY 401/HOLT ROAD INTERCHANGE

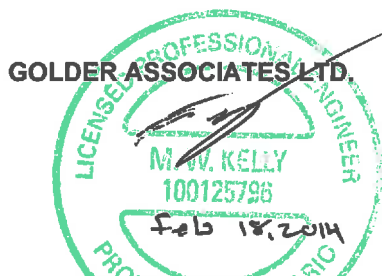
The natural water content measured on three samples of the silt and sand till deposit ranges from about 4 per cent to 7 per cent.

4.3 Groundwater Conditions

Details of the water levels observed in the open boreholes at the time of drilling are summarized on the Record of Borehole sheets in Appendix A of this report. The water level in Borehole 13-2 was measured at a depth of 7.3 m below ground surface corresponding to Elevation 109.0 m in Borehole 13-2; Boreholes 13-11 and 13-19 were dry upon completion of drilling.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Matthew Kelly, P.Eng. and reviewed by Mr. Jorge Costa, P.Eng., a Principal with and Designated MTO Foundations Contact for Golder.



Matthew Kelly, P.Eng.
Geotechnical Engineer



Jorge M. A. Costa, P.Eng.
Designated MTO Foundations Contact, Principal

MWK/JMAC/sm

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FOUNDATION REPORT - HIGH MAST LIGHT POLES HIGHWAY 401/HOLT ROAD INTERCHANGE

REFERENCES

- Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.
- Golder Associates Ltd., 2013 (a). Foundation Investigation Report, Highway 401/Holt Road Underpass Structure, Clarington, Ontario, G.W.P. 2101-08-00
- Golder Associates Ltd., 2013 (b). Foundation Investigation Report, High Fills and Deep Cuts, Highway 401/Holt Road Underpass, Clarington, Ontario, G.W.P. 2101-08-00
- Karrow, P. F., and White, O. L., 1998. *Urban Geology of Canadian Cities*. Geological Association of Canada Special Paper No. 42. St. John's, Nfld.
- Ontario Geological Society, 1991. *Geology of Ontario*. Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2101-08-00

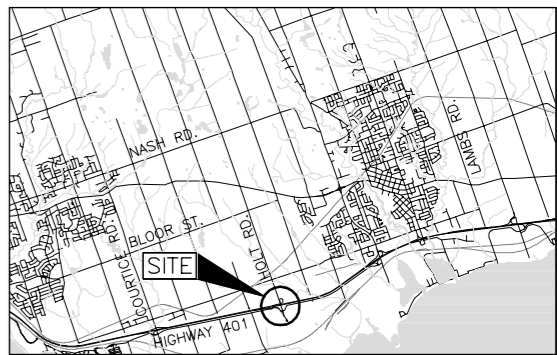
HIGHWAY 401/HOLT ROAD INTERCHANGE
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

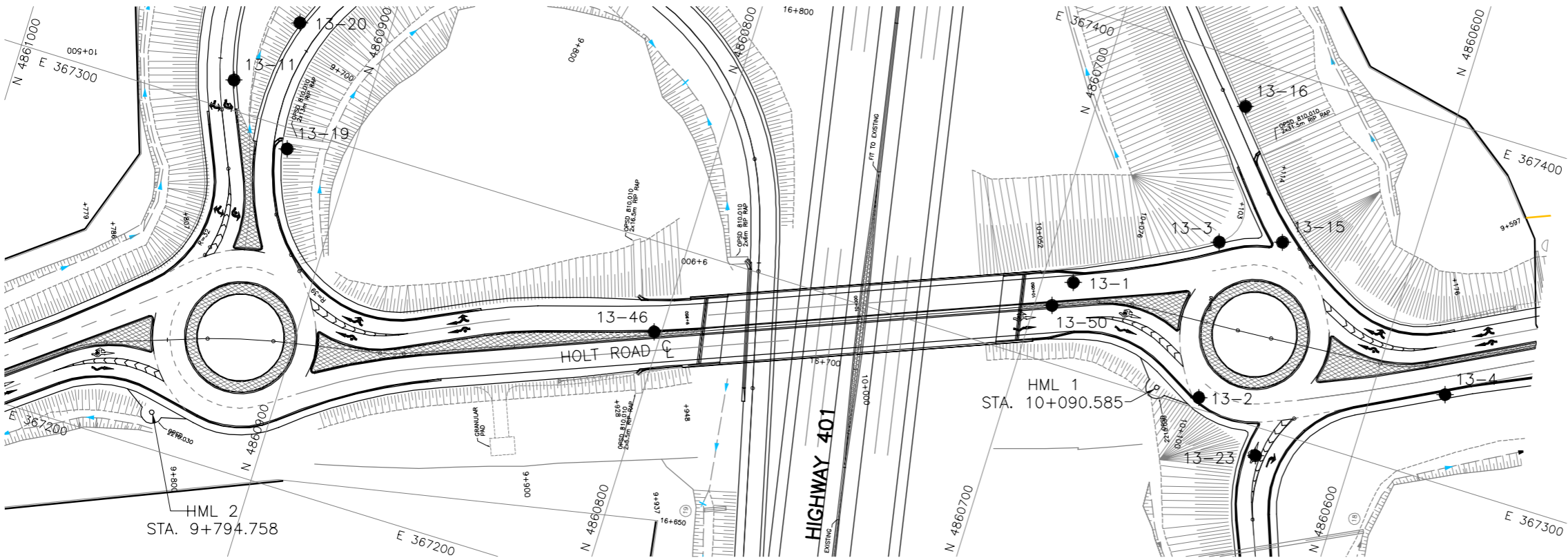
SCALE

2 0 2 4 km



LEGEND

● Borehole - Current Investigation



PLAN

SCALE
15 0 15 30 m

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plan provided in digital format by URS, drawing file no. HoltRd_hmlp to golder.dwg, received January 21, 2014

NO.	DATE	BY	REVISION
Geores No. 30M15-165			
HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2014	SITE:
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. 1



APPENDIX A

Borehole Records

PROJECT		09-1111-0019		RECORD OF BOREHOLE No 13-1				SHEET 1 OF 1		METRIC								
G.W.P.		2101-08-00		LOCATION		N 4860691.2 ; E 367324.1		ORIGINATED BY		JLC								
DIST		HWY 401		BOREHOLE TYPE		120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY		BM								
DATUM		Geodetic		DATE		May 27, 2013		CHECKED BY		MWK								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
111.0	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL		1	SS	3													
110.6	Clayey silt, some sand, trace gravel (FILL)																	
110.2	Brown Moist		2	SS	34													
0.8	CLAYEY SILT with SAND to some sand, trace to some gravel, inferred cobbles throughout (TILL)		3	SS	50/0.13													3 15 49 33
	Hard		4	SS	50/0.13													12 39 37 12
	Brown to grey		5	SS	50/0.08													
	Moist		6	SS	50/0.08													
			7	SS	50/0.08													
			8	SS	50/0.08													
			9	SS	50/0.08													
			10	SS	50/0.05													
101.8	END OF BOREHOLE																	
9.2	NOTES:																	
	1. Water level at a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of drilling.																	
	2. Borehole caved to a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of drill																	

PROJECT		RECORD OF BOREHOLE No 13-2		SHEET 1 OF 1		METRIC										
G.W.P. 09-1111-0019		LOCATION N 4860647.0 ; E 367303.2		ORIGINATED BY JLC												
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM												
DATUM Geodetic		DATE May 30, 2013		CHECKED BY MWK												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
116.3	GROUND SURFACE															
0.0	ASPHALT (150 mm)															
0.2	Sand, some gravel, trace silt (FILL)		1	AS	-											
115.5	Brown Moist		2	SS	37											
0.8	Sandy clayey silt to clayey silt, some sand, trace to some gravel, trace organics and containing rootlets (FILL)		3	SS	36											
	Very stiff to hard		4	SS	33											
	Brown to grey Moist		5	SS	106											
			6	SS	28											
			7	SS	23											
110.7																
5.6	CLAYEY SILT with SAND trace to some gravel, inferred cobbles throughout (TILL)		8	SS	100/0.10											
	Hard Grey Wet															
108.6																
7.7	END OF BOREHOLE		9	SS	100/0.08											
NOTES:																
1. Water level at a depth of 7.3 m below ground surface (Elev. 109.0 m) during drilling.																
2. Borehole caved at a depth of 7.6 m below ground surface (Elev. 108.7 m) upon completion of drilling.																

PROJECT <u>09-1111-0019</u>		RECORD OF BOREHOLE No 13-3		SHEET 1 OF 1		METRIC	
G.W.P. <u>2101-08-00</u>		LOCATION <u>N 4860654.6 ; E 367347.6</u>		ORIGINATED BY <u>JLC</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>120 mm O.D. Continuous Flight Solid Stem Power Auger</u>		COMPILED BY <u>BM</u>			
DATUM <u>Geodetic</u>		DATE <u>May 28, 2013</u>		CHECKED BY <u>MWK</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L				
110.9	GROUND SURFACE																
0.0	TOPSOIL		1	SS	16												
0.3	Clayey silt, some sand, trace to some gravel (FILL) Very stiff Brown Moist		2	SS	21												
110.1	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders at 4.6 m depth (TILL) Very stiff to hard Brown to grey Moist		3	SS	64											6 29 36 29	
0.8			4	SS	50/0.13												
			5	SS	50/0.10												
			6	SS	50/0.08												
			7	SS	50/0.02											4 39 49 8	
	Augers grinding on inferred cobbles and boulders		8	SS	50/0.02												
			9	SS	50/0.10											4 35 45 16	
103.2																	
7.7																	

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE No 13-4		SHEET 1 OF 1		METRIC											
G.W.P. 09-1111-0019		LOCATION N 4860579.7 ; E 367324.9		ORIGINATED BY JLC													
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM													
DATUM Geodetic		DATE May 27, 2013		CHECKED BY MWK													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	Wp	W	WL	10 20 30					
113.5	GROUND SURFACE																
0.0	TOPSOIL																
113.1			1	SS	27		113										
0.4	CLAYEY SILT with SAND trace gravel, inferred cobbles and boulders (TILL) Hard Brown to grey Moist		2	SS	50/0.15	▽	112										16 38 34 12
			3	SS	50/0.08		111										9 43 38 10
	----- Augers grinding on inferred cobbles and boulders between depths of 2.13 m and 4.6 m		4	SS	50/0.08		110										
			5	SS	50/0.08		109										
	----- Augers grinding on inferred cobbles and boulders at a depth of 3.8 m		6	SS	50/0.08												
108.9	END OF BOREHOLE		7	SS	50/0.08												
4.7	NOTES: 1. Water level at a depth of 0.9 m below ground surface (Elev. 112.6 m) during drilling. 2. Borehole caved to a depth of 3.4 m below ground surface (Elev. 110.1 m) upon completion of drilling.																

PROJECT		RECORD OF BOREHOLE No 13-11		SHEET 1 OF 1		METRIC											
G.W.P. 09-1111-0019		LOCATION N 4860938.7 ; E 367308.4		ORIGINATED BY JLC													
DIST _____ HWY 401		BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM													
DATUM Geodetic		DATE June 4, 2013		CHECKED BY MWK													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30				
109.7	GROUND SURFACE																
0.0	TOPSOIL		1	SS	23												
109.3	Very stiff																
0.4	Dark brown Moist																
	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders at 1.5 m to 4.7 m depth (TILL)		2	SS	50/0.10		109										
	Hard Brown Moist		3	SS	50/0.13		108										
	Augers grinding on inferred cobbles and boulders		4	SS	50/0.05		107										9 45 35 11
			5	SS	50/0.05												
			6	SS	50/0.05		106										
105.1	END OF BOREHOLE		7	SS	50/0.08												9 41 35 15
4.7	NOTE: 1. Open borehole was dry upon completion of drilling.																

PROJECT		RECORD OF BOREHOLE No 13-15		SHEET 1 OF 1		METRIC																		
G.W.P. 09-1111-0019		LOCATION N 4860637.2 ; E 367352.9		ORIGINATED BY JLC																				
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM																				
DATUM Geodetic		DATE May 31, 2013		CHECKED BY MWK																				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																			
111.1	GROUND SURFACE																							
0.0	TOPSOIL		1	SS	18																			
110.7																								
0.4	Sandy clayey silt, trace gravel (FILL) Very stiff Brown Moist		2	SS	28																			
109.7																								
1.4	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders at 4.6 m depth (TILL) Hard Brown to grey Moist		3	SS	50																			
			4	SS	50/13																			
			5	SS	50/10																			
			6	SS	50/10																			
			7	SS	50/10																			
	Augers grinding on inferred cobbles and boulders		8	SS	50/10																			
			9	SS	50/10																			
103.4	END OF BOREHOLE																							
7.7	NOTES: 1. Water level at a depth of 4.0 m below ground surface (Elev. 107.1 m) upon completion of drilling. 2. Borehole caved to a depth of 7.2 m below ground surface (Elev. 103.9 m) upon completion of drill																							

PROJECT		RECORD OF BOREHOLE No 13-16		SHEET 1 OF 1		METRIC							
G.W.P. 09-1111-0019		LOCATION N 4860658.9 ; E 367387.0		ORIGINATED BY JLC									
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM									
DATUM Geodetic		DATE May 30, 2013		CHECKED BY MWK									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L			
110.1	GROUND SURFACE							20 40 60 80 100					
0.0	TOPSOIL		1	SS	25								7 18 43 32
109.7	Clayey silt, some sand, trace to some gravel (FILL) Very stiff Brown Moist		2	SS	54								
109.3	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders throughout (TILL) Hard Brown to grey Moist to wet		3	SS	68								
0.8			4	SS	78								
			5	SS	100/0.13								13 47 28 12
			6	SS	100/0.10								
			7	SS	100/0.13								10 48 29 13
			8A 8B	SS	140/0.25								
			9	SS	100/0.05								
102.4	END OF BOREHOLE												
7.7	NOTES: 1. Water level at a depth of 4.3 m below ground surface (Elev. 105.8 m) upon completion of drilling. 2. Borehole caved at a depth of 6.5 m below ground surface (Elev. 103.6 m) upon completion of drill												

PROJECT		RECORD OF BOREHOLE		No 13-19		SHEET 1 OF 1		METRIC										
G.W.P. 09-1111-0019		LOCATION		N 4860918.3 ; E 367294.0		ORIGINATED BY		JLC										
DIST _____ HWY 401		BOREHOLE TYPE		108 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY		BM										
DATUM Geodetic		DATE		June 4, 2013		CHECKED BY		MWK										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
110.0	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL							20	40	60	80	100						
0.3	Silty SAND, trace gravel, trace clay Compact to very dense Brown Moist		1	SS	16													
			2	SS	73													
108.5			3	SS	50/0.08													
1.5	SILT and SAND, some clay, trace to some gravel, inferred cobbles and boulders at 4.0 m and 4.3 m depth (TILL) Very dense Brown Moist		4	SS	50/0.08													
			5	SS	50/0.10													
			6	SS	50/0.05													
			7	SS	50/0.05													
105.4	Auger grinding on inferred cobbles and boulders																	
4.6	END OF BOREHOLE																	
NOTE: 1. Open borehole was dry upon completion of drilling.																		

PROJECT		RECORD OF BOREHOLE		No 13-20		SHEET 1 OF 1		METRIC								
G.W.P. 09-1111-0019		LOCATION		N 4860925.5 ; E 367329.7		ORIGINATED BY		JLC								
DIST		HWY 401		BOREHOLE TYPE		108 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY								
DATUM		Geodetic		DATE		May 31, 2013		CHECKED BY								
								MWK								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
109.1	GROUND SURFACE															
0.0	TOPSOIL															
0.2	Silty SAND, some gravel, trace clay, containing rootlets		1	SS	21											
108.4	Compact Brown Moist		2	SS	39											
0.7	SILT and SAND, trace to some clay, trace to some gravel (TILL) Dense to very dense Brown Moist		3	SS	50/0.13											
			4	SS	50/0.08											
			5	SS	50/0.08											
			6	SS	50/0.08											
			7	SS	50/0.13											
			8	SS	50/0.13											
102.9	END OF BOREHOLE															
6.2	NOTE: 1. Open borehole was dry upon completion of drilling.															

PROJECT		RECORD OF BOREHOLE No 13-23		SHEET 1 OF 1		METRIC								
G.W.P. 09-1111-0019		LOCATION N 4860626.5 ; E 367292.1		ORIGINATED BY JLC										
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM										
DATUM Geodetic		DATE May 30, 2013		CHECKED BY MWK										
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W _p	W			W _L
113.2	GROUND SURFACE						20 40 60 80 100							
0.0	TOPSOIL						20 40 60 80 100							
112.7	Firm		1	SS	8									
0.5	Dark brown		2	SS	36									
	Moist		3	SS	100/0.13									
	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders throughout (TILL)		4	SS	100/0.08									
	Hard		5	SS	100/0.10									
	Brown to grey		6	SS	100/0.09									
	Moist		7	SS	100/0.09									
			8	SS	100/0.09									
107.1	END OF BOREHOLE													
6.2	NOTE: 1. Water level in open borehole at a depth of 4.9 m below ground surface (Elev. 108.3 m) upon completion of drilling.													

PROJECT 09-1111-0019		RECORD OF BOREHOLE No 13-46		SHEET 1 OF 1		METRIC	
G.W.P. 2101-08-00		LOCATION N 4860802.0 ; E 367275.0		ORIGINATED BY JLC			
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM			
DATUM Geodetic		DATE June 11, 2013		CHECKED BY MWK			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
114.1	GROUND SURFACE																
0.0	TOPSOIL		1	SS	19												
113.5	Compact Dark brown Moist																
0.6	Sand and silt, some gravel, some clay, trace organics (FILL) Compact to very dense Grey to black Moist		2	SS	87												
			3	SS	29												
			4	SS	24												
	Pockets of wood fibres/rootlets below Elev. 111.0 m		5	SS	37											16 38 32 14	
			6	SS	36												
109.7	CLAYEY SILT with SAND, trace to some gravel (TILL) Hard Brown to grey Moist		7	SS	97											10 39 36 15	
4.4	Auger grinding on possible cobbles and boulders below 5.1 m depth		8	SS	50/0.03												
			9	SS	50/0.03												
105.8	SAND and SILT, trace to some gravel, some clay (TILL) Very dense Grey Moist		10	SS	50/0.05												
8.3																	
104.9	END OF BOREHOLE																
9.2	NOTES: 1. Borehole caved at a depth of 8.7 m below ground surface (Elev. 105.4 m) upon completion of drilling. 2. Water level in caved borehole at a depth of 6.2 m below ground surface (Elev. 107.9 m) upon completion of drilling. 3. Water level measurements in Piezometer: Date Depth (m) Elev. (m) 09/10/13 3.9 110.2																

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE No 13-50		SHEET 1 OF 1		METRIC											
G.W.P. 09-1111-0019		LOCATION N 4860695.0 ; E 367316.0		ORIGINATED BY JLC													
DIST _____ HWY 401		BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger		COMPILED BY BM													
DATUM Geodetic		DATE May 27, 2013		CHECKED BY MWK													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30				
111.0	GROUND SURFACE																
0.0	TOPSOIL																
110.6	Loose Brown Moist		1	SS	8												
110.2	Clayey silt, some sand, trace gravel, trace organics (FILL) Dark brown Moist		2	SS	47		110										5 37 41 17
0.8	CLAYEY SILT with SAND, trace to some gravel, occasional silt seams (TILL) Hard Brown to grey Moist		3	SS	50/0.13												2 39 44 15
			4	SS	50/0.10		109										
			5	SS	50/0.08		108										10 42 35 13
			6	SS	50/0.06		107										
			7	SS	50/0.03		106										
			8	SS	50/0.05		105										
			9	SS	50/0.08		104										
			10	SS	50/0.08		103										
101.8	END OF BOREHOLE						102										
9.2	NOTES: 1. Water level at a depth of 5.5 m below ground surface (Elev. 105.5 m) during drilling. 2. Borehole caved to a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of drilling.																



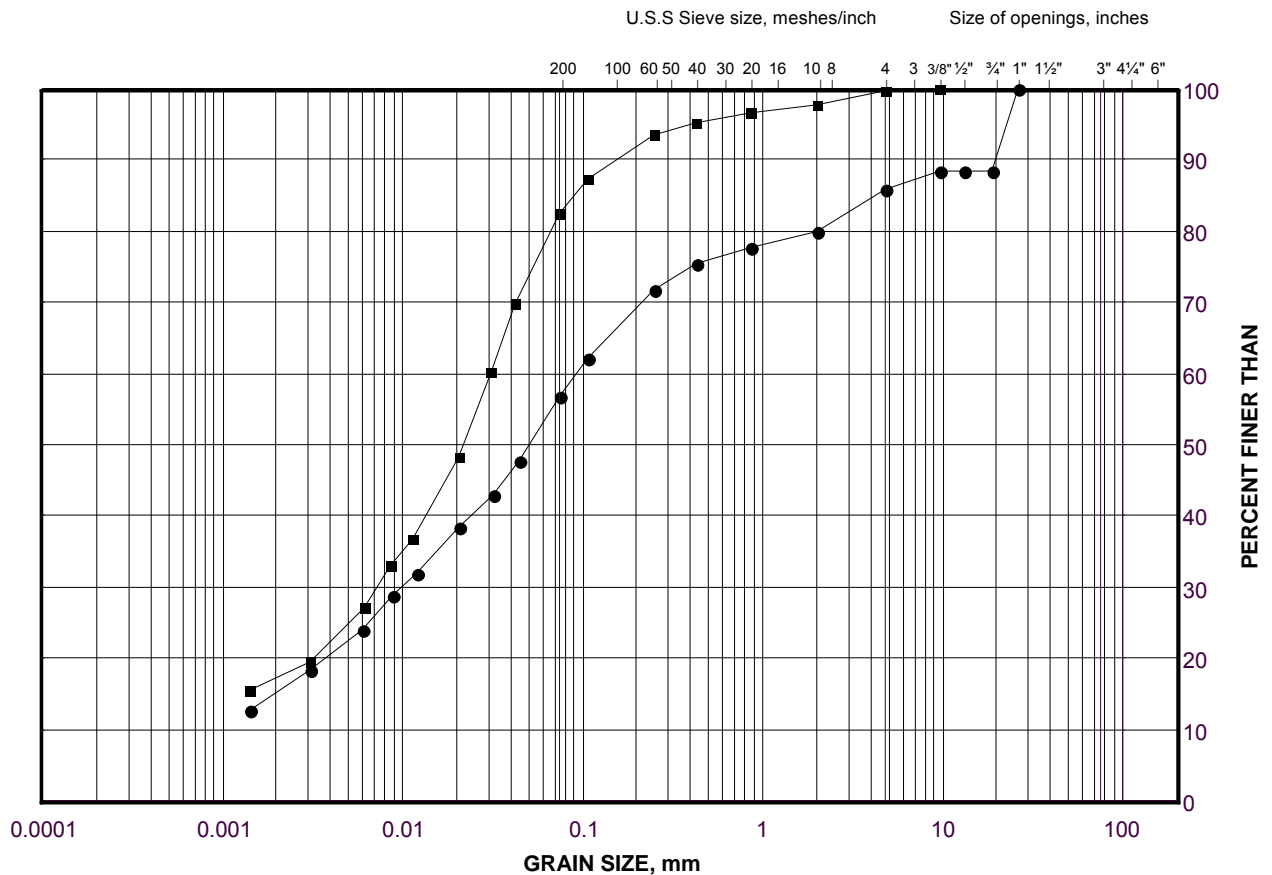
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (Fill)

FIGURE B1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

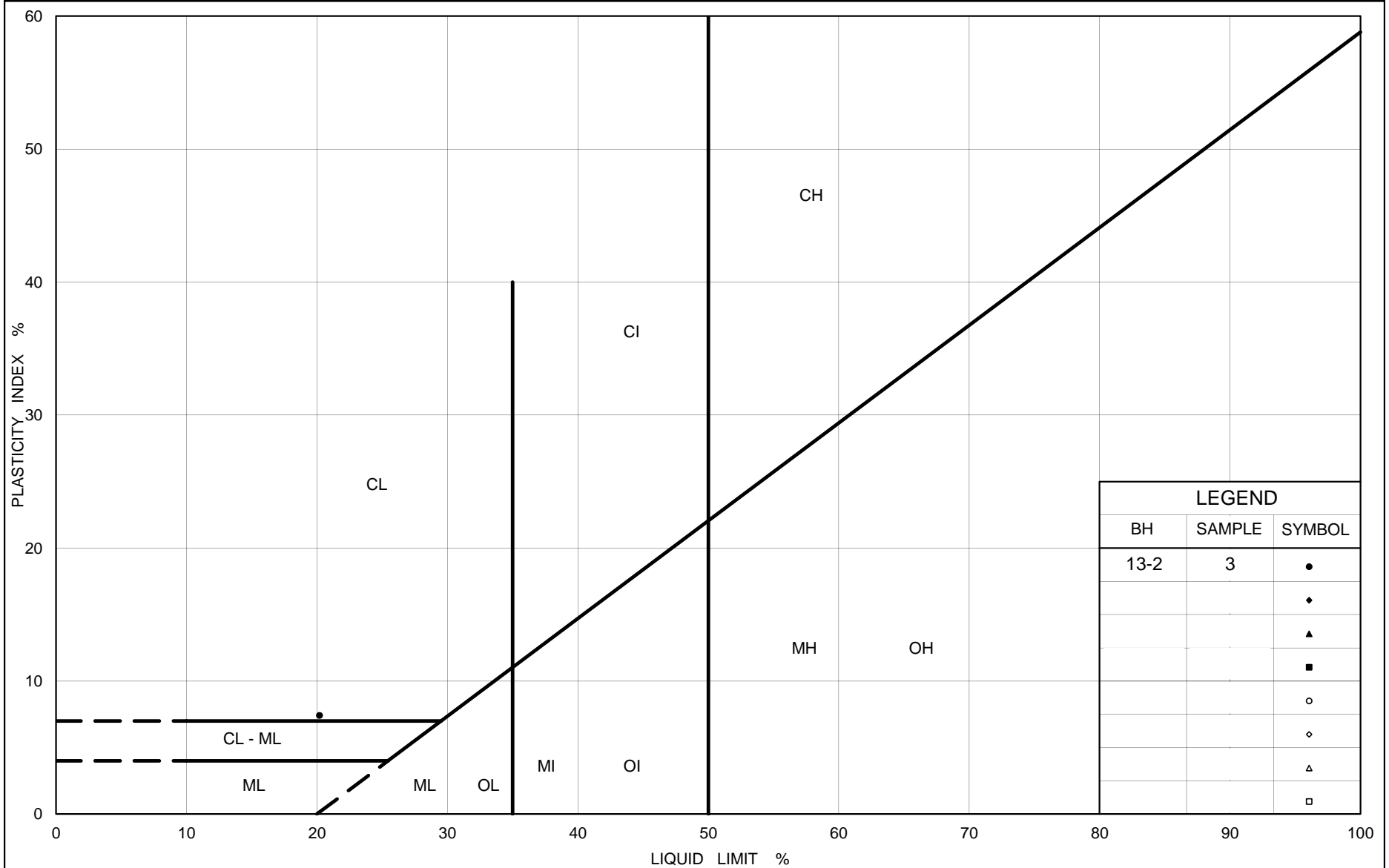
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-2	3	114.5
■	13-2	5	113.0

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PLASTICITY CHART

Clayey Silt (Fill)

Figure No. B2

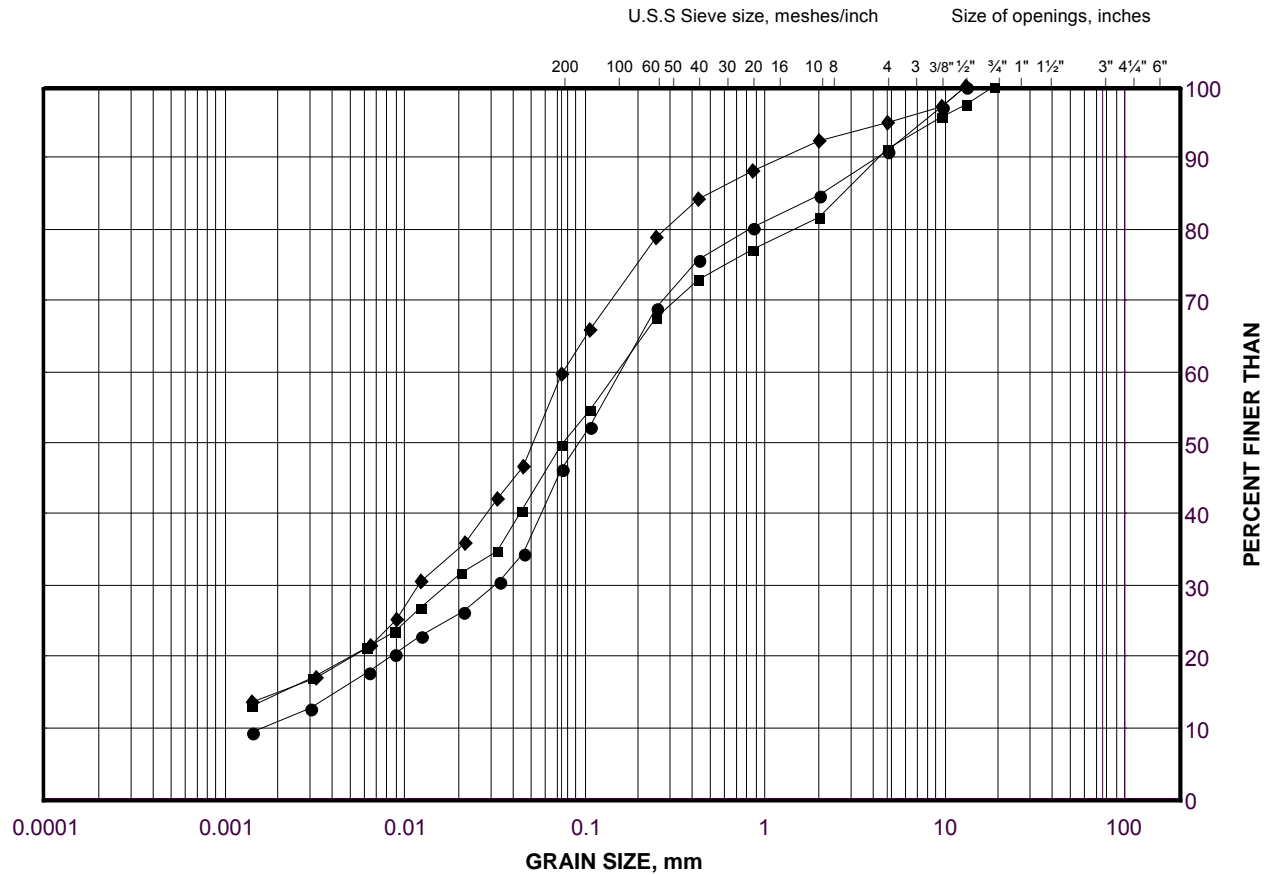
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GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (Till)

FIGURE B3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

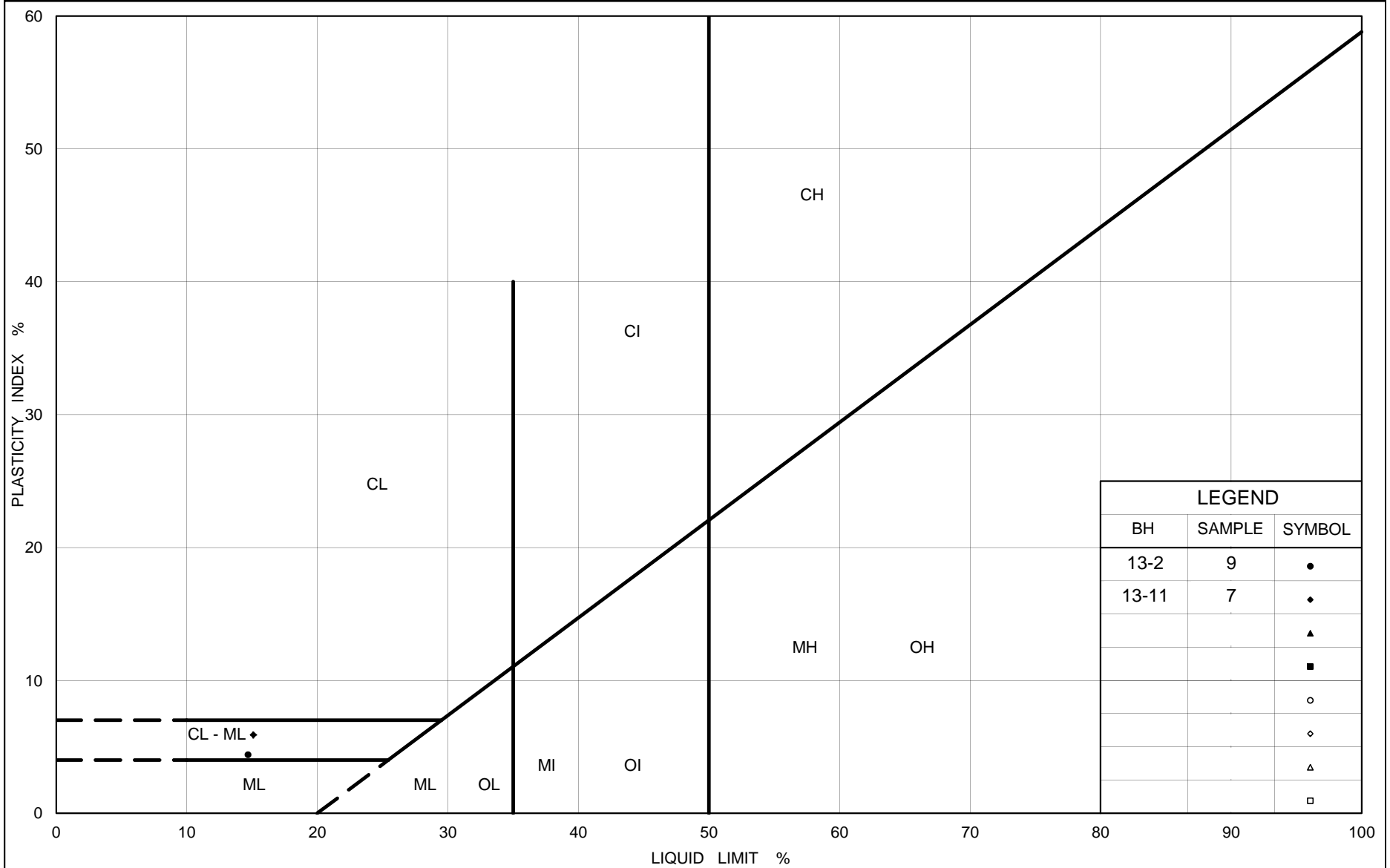
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-11	4	107.4
■	13-11	7	105.2
◆	13-2	8	110.1

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PLASTICITY CHART

Clayey Silt (Till)

Figure No. B4

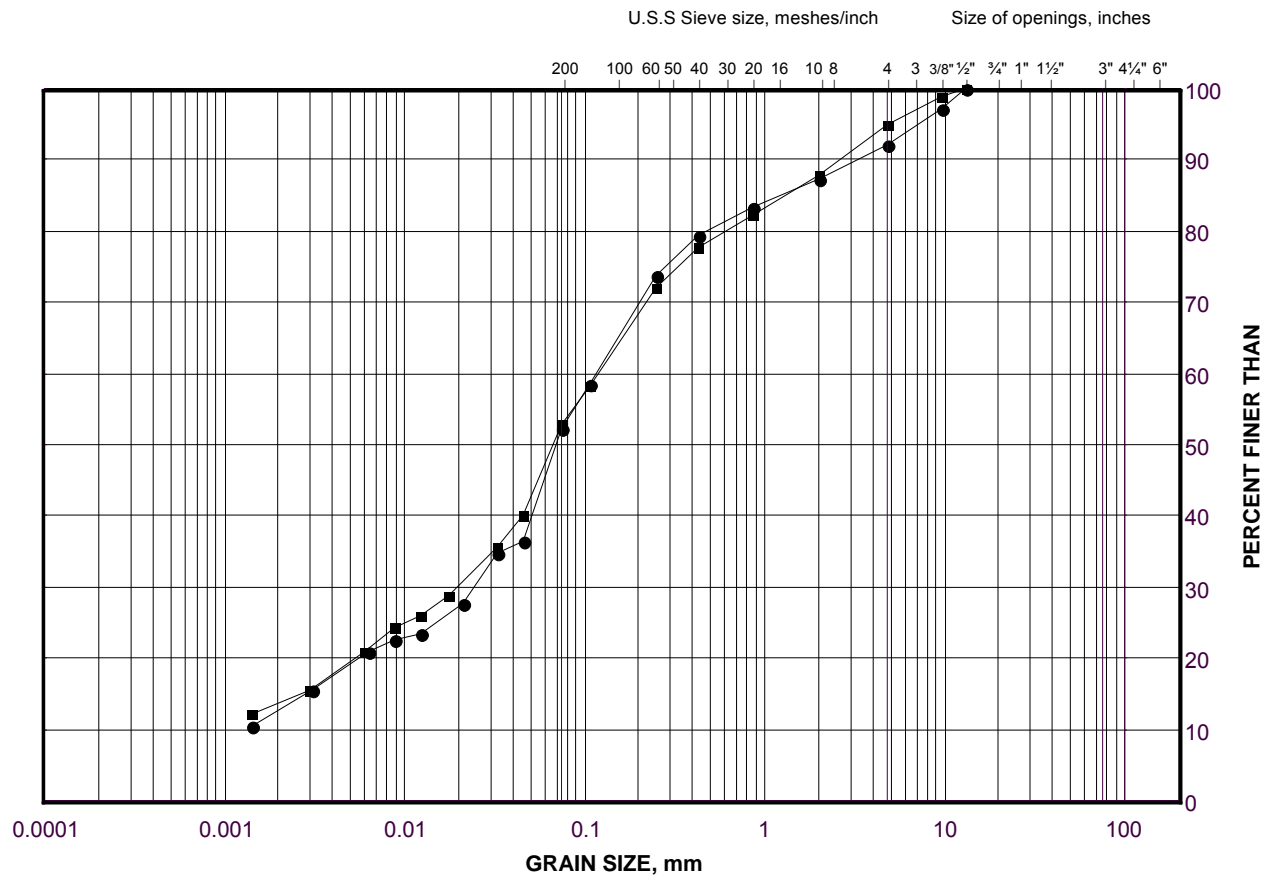
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GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt and Sand (Till)

FIGURE B5



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-19	5	106.9
■	13-19	7	105.4

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